
THRUST 2 ORDNANCE

USER NEEDS

The focus of this Thrust is to introduce affordable, high probability of kill, conventional weapons to the Air Force inventory. The user needs presented below are extracted from Operational Requirements Documents, munitions TPIPT study efforts, the ACC Mission Area Plans for Counter Air, Strategic Attack/Interdiction, Close Air Support/Interdiction, Theater Missile Defense, Electronic Combat, and the Air Force Special Operations Command (AFSOC) Weapons System's Roadmap, 2nd Edition.

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Fixed Target/General Purpose Weapon Options

- All-up round fuzing to reduce support costs
- Insensitive explosives to reduce safety hazard
- Jam resistant proximity sensor
- Enhanced kill mechanisms for increasing effectiveness of smaller weapons

Fixed Hard Target Weapon Options

- Smart fuzing to optimize warhead burst point
- Increased aircraft loadouts through reduced warhead size and compressed carriage
- Increased explosive performance
- Increased mission kill capability and payload flexibility
- Neutralize biological and chemical targets
- Hard target fuzing for gunship projectiles

Fixed Target Weapon Options (Standoff)

- Force multiplier submunitions/munitions
- Unitary heavy metal penetrating warheads

Mobile Target Weapon Options (Direct and Standoff)

- Multimode warhead effective against a broad spectrum of materiel targets
- Insensitive explosive for submunitions
- Reduced cost per kill and increased kills per aircraft sortie

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Medium and Short Range Missile Options

- Improved warhead burst point control
- Enhanced lethality warheads
- Fuzing for low observable threats
- Guidance integrated fuzing
- Increased maneuverability, performance and aircraft loadouts

See Figure 6 for major Thrust efforts.

GOALS

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For safety and reliability, bomb fuzes are environmentally sealed and stored in separate containers from the bomb bodies. The fuzes, when removed, must be used within 60 days. Lessons learned during Desert Storm demonstrated that the logistics pipeline and build-up effort for general purpose bombs were excessively complex, expensive, and time consuming.

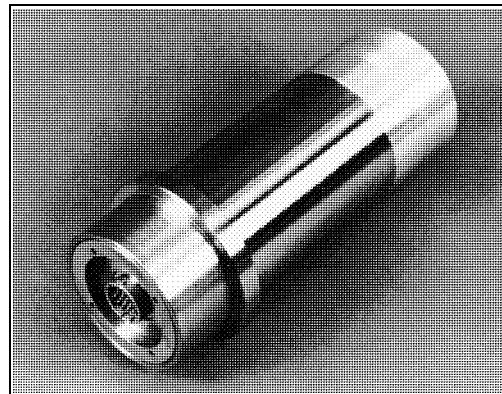


FIGURE 7. HARD TARGET SMART FUZE

- Advances in solid-state electronic fuzing and insensitive explosive booster designs will make safety, reliability, and longevity of fuzed general purpose bombs during transport and storage practical.
- Solid-state electronic fuzing with large insensitive boosters can be used with present Mk-80 series bombs; however, the payoff in safety does not come until the bombs are filled with insensitive explosive. It is too

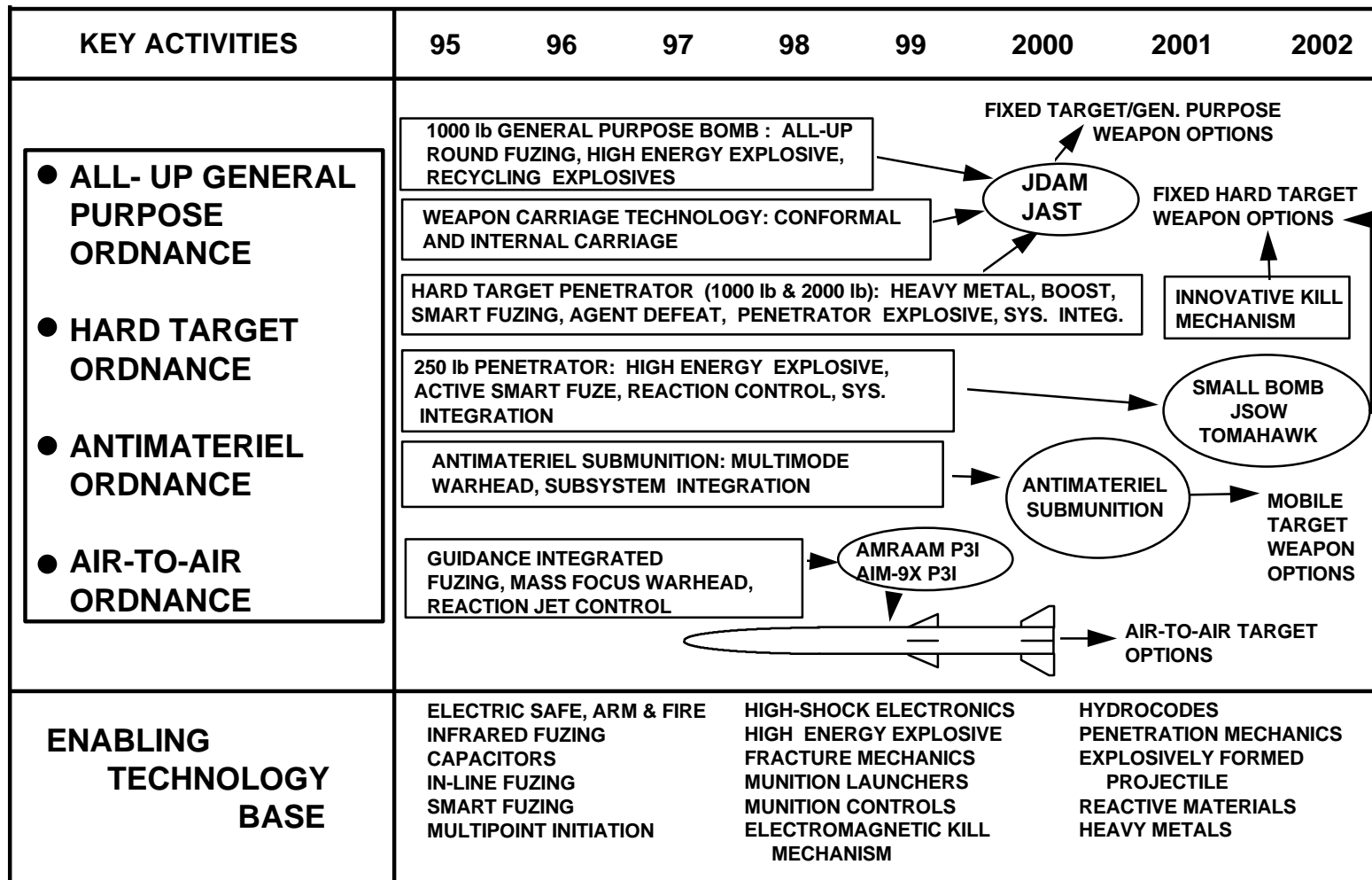


FIGURE 6. THRUST NO. 2 - ORDNANCE

costly to retrofit the large quantity of Mk-80 series bombs already in the inventory with insensitive explosives. The best strategy is to advance and introduce fuze technology now and introduce an insensitive explosive fill during future general purpose bomb buys.

General purpose bombs use proximity sensors to increase blast and fragmentation effects on soft targets. These sensors are expensive, bulky, and susceptible to electronic countermeasures (ECM) and jamming. The present proximity sensor fits in the bomb nose fuze well and causes the bomb to carry a tail fuze with the associated build-up costs.

- Advancements in monolithic microwave integrated circuits (MMIC) and wideband radar technology will lower the cost and will improve reliability and supportability of these sensors.
- Advances in digital signal processing will reduce susceptibility to ECM jamming.
- The Joint Programmable Fuze being procured in the JDAM program is a general purpose bomb fuze which interfaces with a nose proximity sensor. It does address the All-Up Munition issue of storage life but not the solid-state electronics and fuze fire train needed to make it safe for transporting and storing in the warhead or the ECM hardened proximity sensor issues. We envision the All-Up Munition technology area to provide product improvement options for the Joint Programmable Fuze.

Aircraft costs are directly related to aircraft weight, thus the continuing emphasis is reduction in size and weight of the total weapon system (aircraft and armament). Kill mechanisms for delivering more energy on the target or more effectively coupling energy into the target are being explored. These technologies provide the opportunity to reduce the weapon size and weight while maintaining the effectiveness currently available in larger munitions. Smaller, highly effective weapons result in reduced aircraft stowage volumes/areas and thus reduced aircraft size, weight and costs.

- Develop innovative kill mechanisms which couple explosive and electrical energies to enhance the

destructive power delivered to the target. Investigate capabilities obtainable from simultaneously applying multiple kill phenomenology to targets.

For fixed hard target weapon options, we develop ordnance capable of penetrating complex hard targets such as heavily hardened command and control bunkers, aircraft shelters, runways, and concrete buildings. We also develop smart fuzing technology with layer counting, depth of burial, void sensing, and programmable time delay capabilities. To improve weapon accuracy and performance, we use low cost inertial guidance and optimized impact conditions through trajectory shaping and use of reaction control systems such that the weapon and weapon velocity are vertical to the target at impact.

Warhead case and hard target fuzing technologies are emphasized that reduce cost, improve producibility, and increase reliability of penetrator munitions.

The design trades to determine the penetration requirements and number of weapons needed to defeat hardened targets with affordable weapons are very complex. To begin such a study, a definition of the enemy target set and the tactics of the delivery platforms are required. With no clear enemy today, a specific target set cannot be defined. Also, delivery tactics have many variables and are designed to be unpredictable to ensure aircraft/pilot survivability. Aircraft ability to survive at high altitude and find targets through cloud cover are two variables that have a dramatic effect on the decision to boost a weapon or let it free fall. Boosted munitions affect affordability, aircraft compatibility, and the number of munitions that can be carried. There is an inverse relationship between numbers of targets and penetration depths needed to defeat the target. The advanced penetration capability is more expensive but also more effective against heavily hardened targets. But these targets are fewer in numbers requiring fewer weapons to defeat them. For a given impact velocity, the penetration capability decreases with the decreasing size and weight of the penetrator. However, the number of weapons that a platform can carry increases with the decrease in penetrator weight. These penetrator design trends indicate that a two-

pronged approach is best: a high payoff deep penetration capability and an increased force multiplier capability (carriage of more weapons).

Two penetrating munitions in the inventory today are the GBU-27 and GBU-28. Both are non-boosted, laser guided systems and use fixed time delay fuze technology. Operational effectiveness is degraded when using fixed time delay fuzing because accurate intelligence data on the design and construction of all hard targets are lacking. A layer counting fuze with a void sensing capability only requires general construction data about a target to be optimally effective.

The GBU-28 with deep penetration capability, has poor aircraft compatibility characteristics and a very limited employment envelope, i.e., only two aircraft types, severe maneuver restrictions, high altitude release, and clear day. This drastically reduces its utility in time critical scenarios or operations where we do not have complete air superiority. The GBU-27 has better aircraft compatibility characteristics but has less penetration ability. Its 2000-pound weight and the small number that can be carried on aircraft severely limit its capability as a force multiplier. The JDAM program will increase the force multiplier capability of the 2000-lb warhead by incorporating inertial guidance and qualifying it on bomber aircraft (multiple kills per pass with bomber aircraft). However, a severe limitation of both GBU-27 and GBU-28 systems is the lack of a reliable and smart fuze and a multiple kills per pass on fighter size aircraft. Hard target technology will provide design options for product improvement of ordnance packages for JDAM in the 1000-lb and 2000-lb class warheads and a 250-lb class ordnance package for multiple carriage on fighter aircraft.

- Develop a smart fuze with void sensing and layer counting capability to provide accurate warhead burst point control for complex hard targets. The fuze will count floor layers and detonate the warhead in a predetermined void (room). The first generation smart fuze transitioned into the GBU-28 program in FY95. The fuze is also compatible with the GBU-27.
- Develop velocity augmented warhead technology which can accelerate warheads for deep penetration,

but at sizes and weights which can be carried on a variety of attack aircraft. The ordnance package would be an option for a replacement for the gravity drop BLU-109 warhead presently planned for JDAM.

- Develop inertially aided small bomb technologies for hard targets which would provide multiple carriage per aircraft station and defeat multiple structures on a single sortie. Technologies required are low cost inertial guidance and second generation Smart Fuzing (autonomous decision making rather than preprogrammed).
- Develop options for heavy metal penetrating warheads. The payoff would be improved penetration over the present steel case designs (more weight per cross section) for both gravity and velocity augmented concepts.

Current and developmental air-to-surface weapons are typically right circular cylinders with large aerosurfaces and control fins. These weapons require large areas/volumes for aircraft carriage and have large incarriage drag and signature. Current penetrator weapons such as the GBU-27 and GBU-28 utilizes canard controls to steer the weapon to the target. This type of control system provides little maneuverability and results in suboptimum penetrator impact conditions. Reaction control technology coupled with onboard inertial measurement unit and guidance laws to reduce angle-of-attack and optimize the impact angle offer significant improvements in weapon performance and effectiveness. This technology is vital to improving aircraft mission effectiveness by improving range/payload, aircraft survivability, and kill per sortie while reducing cost per kill. This technology is vital to improving aircraft mission effectiveness by improving range/payload, aircraft survivability, and kill per sortie while reducing cost per kill.

- Develop weapons which can be carried conformally or internally with minimum stowage volume. Implement control systems with minimum span aerosurfaces or reaction controls which provide additional reductions to weapon size. Resulting systems will be compatible with external carriage on current aircraft and internal carriage on future advanced fighter aircraft.

Penetrator design requires a thick walled warhead case for increasing penetration and ensuring warhead survivability during the penetration event. This thick wall requirement results in low volumes for explosive fills which, in turn, drives a requirement for higher energy density explosives and new target defeat mechanisms. These advanced target defeat mechanisms can be used individually or combined to provide the effectiveness needed. Target defeat technologies are being developed for large hardened targets such as command, control and communication facilities and for biological and chemical weapon facilities.

- Develop reactive materiel fills for warheads which provide a greater impulse than high explosive for a given volume. This technology would increase the effectiveness of the smaller warhead options for JDAM product improvement.
- Develop electromagnetic energy weapon payloads which provide wide area mission kills against targets which rely upon computers, communication and power systems. Methods for effectively coupling energy from the weapon into the target will be investigated.
- Develop innovative kill mechanisms that will neutralize or deny access to biological and chemical agents in hardened storage or production facilities.
- Adapt hard target smart fuze technology to improve the effectiveness of 105-mm projectiles fired from gunships.

Strategic attack, interdiction, and close air support will continue to be primary missions for advanced tactical aircraft. Targets include enemy air defenses, tactical ballistic missile sites, and the whole range of ground mobile targets such as those included in a motorized rifle battalion. To meet the user's need for defeating a broad spectrum of antimateriel targets, our multimode warhead with enhanced lethality is being developed. The large number of targets and limited aircraft carriage capability requires a cluster munition approach to defeat dispersed ground targets.

Until recently different warheads had to be fielded to get the optimum lethality for each different class of target. Armament Directorate in-house development has demonstrated the feasibility of a single liner warhead being initiated in any one of the three modes (long penetrating rod, explosively formed aerostable penetrator, or fragmentation). This technology breakthrough enables one submunition to be lethal against the wide spectrum of materiel targets.

Concurrently with the multimode warhead, the Advanced Guidance Thrust has developed an affordable laser diode sensor which can classify, in real time, targets such as tanks, trucks, relocatable missile launchers, or radar sites. This sensor and a maneuvering submunition airframe has matured in the Low Cost Anti-Armor Submunition (LOCAAS) program. The Antimateriel Submunition of the future is envisioned as a second generation smart submunition which will combine autonomous target classification with significantly increased area coverage and a selectable multimode warhead. Detailed cost projections verified by independent government cost analysis indicates these submunitions could be built in large quantities for under \$20,000 each. Joint service use of these effective munitions against ground mobile targets requires them to be carried safely on Navy ships with Navy insensitive munition requirements.

- Continue advancement of multimode warhead technology which can be selectively fired as a penetrating jet, aerostable slug, or multiple fragments. This will provide technology options for next generation antimateriel submunitions.

Current antimateriel submunitions are limited in their area coverage and search patterns, they also have limited lethality against the broad spectrum of antimateriel targets which includes armored vehicles, trucks, and missile sites.

- Continue development of low cost antimateriel submunitions which provide significantly lower cost per kill than existing submunitions. Combine a highly maneuverable, compressed carriage airframe with an affordable laser radar seeker and an enhanced lethality multimode warhead. Resulting capabilities include real-time target classification, the ability to maneuver

the submunition to the target and matching of the most effective kill mechanism to the target encountered. The full spectrum of ground mobile targets (trucks, tanks, surface-to-air missiles, and antiaircraft artillery) can be defeated with a single submunition. Initial development of the sensor and submunition airframe was accomplished in the joint Air Force and Army Low Cost Anti-Armor Submunition (LOCAAS) Balanced Technology Initiative program.

- Develop technologies for incorporating multiple kill methods into a single antimateriel submunition. Potential mechanisms include conventional explosively projected fragments and projectiles, conductivity of high energy currents and transmission of high powered electromagnetic pulses.

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Enhancement of air-to-air ordnance package performance requires that the target detection device and warhead burst point calculations utilize all information available to the missile. Effective coupling of the warhead energy onto the target requires improvements in directing the kill mechanism such that as much of the kill mechanism as possible interacts with the target. Data from the missile seeker can be used to project the encounter geometry and velocity. Further enhancement of the burst point control algorithms requires that the volume viewed by the target detection device be expanded to cover as much of missile forward hemisphere as possible. Reductions in target signatures requires that the fuze be capable of detecting low observable targets.

- Develop guidance integrated fuzing systems which accurately predict the optimum warhead burst location using all available data from the seeker and guidance packages.
- Develop an imaging seeker/fuze sensor which looks in the forward hemisphere and provides missile/target encounter geometry projections for enhancing warhead burst point calculations and improving effectiveness.
- Develop mass focusing warheads which direct the fragment and blast patterns such that the majority of the warhead energy is coupled into the target.

- Develop fuze sensors which have greater detection ranges against low observable targets in weather.

Improvements in enemy aircraft technology and the proliferation of advanced aircraft have resulted in nations possessing fighter aircraft nearly equal to our own. The weapons suite for these aircraft is in some areas (e.g., aerodynamics) superior to our current systems. Technologies such as reaction jets will eliminate the need for missile fins, providing compressed missile carriage which will double missile loadouts for a given carriage volume.

This technology supports potential future product improvements to the AIM-9 Sidewinder and AIM-120 AMRAAM systems. The munition control system technologies of the thrust are also applicable to the air-to-surface weapon systems.

- Develop technologies for increasing missile maneuverability and high off-boresight launch capabilities. These technologies will provide increased first shot opportunities and minimize the time required for missile launch and destruction of the enemy aircraft.
- Develop advanced low cost, supportable, munition control system technologies which provide decreased missile flight times, high off-boresight, and high angle-of-attack launch capabilities. Technologies such as reaction jets will eliminate the need for missile fins, providing compressed missile carriage which will double missile loadouts for a given carriage volume.

MAJOR ACCOMPLISHMENTS

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- Demonstrated void sensing fuze capability for hard target weapons in GBU-27 and GBU-28 flight tests against hardened underground targets and procured 150 units for testing and deployment in contingency operations.
- Continued large scale tests of agent defeat kill mechanism for neutralizing biological weapons.

- Continued small scale tests of agent defeat neutralization against chemical weapon agents.

- Transitioned hard target fuze for gunship 105-mm projectile; 195,000 units will be produced for Air Force inventory.

- Completed preliminary design for multimode antimateriel warhead brassboard.

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- Transitioned highly reliable electronic safe, arm and fire device to AMRAAM.

- Transitioned low cost fragmenting warhead with increased effectiveness to AMRAAM.

- Completed testing of jet reaction control device for air-to-air missiles.

CHANGES FROM LAST YEAR

Congressional recommendation was made to fund advanced penetrator efforts with OSD Counter Proliferation funds. Presently receiving funding for heavy walled penetrator design. Joint planning with the Defense Nuclear Agency and OSD is being accomplished for demonstrating technologies to defeat biological and chemical targets.

MILESTONES

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Fixed target/general support weapon technologies

- Demonstrate environmentally protected electronic controller, fire set, and proximity sensor for an all-up munition fuze - FY97.
- Demonstrate explosive recycling technologies which provide low cost recycling of military weapon explosives with environmentally safe products - FY97.
- Demonstrate safety of all-up munition fuze and explosively filled bomb for transportation and storage - FY98.

Fixed hard target weapon technologies

- Demonstrate advanced penetrator explosive formulations for providing insensitive explosive fills which survive penetration while increasing performance - FY96.

- Perform large scale testing of agent defeat kill mechanism for defeating biological and chemical weapons -FY96.

- Demonstrate advanced external weapon carriage suspension and release technologies - FY98.

- Demonstrate 2250-lb and 1000-lb warhead technology compatibility with inertial and precision guidance and develop flight control algorithms to ensure small angle-of-attack at impact - FY98.

- Develop technology for a 2250-lb munition with velocity augmentation and physical compatibility with the F-16, F-15, F-117, F-18, B-1, and B-2 - FY97-FY01.

Fixed target weapon technology (standoff)

- Demonstrate 250-lb force multiplier warhead compatibility with multiple weapon carriage on a single aircraft station - FY97.

- Demonstrate active autonomous smart fuzing hardware and software against runways, buildings, and aircraft shelters. (Fuze describes type of target during the penetration event and autonomously fuzes) - FY99.

Mobile target weapon technologies (direct and standoff)

- Demonstrate compatibility of the multimode warhead with airframe and guidance - FY96.
- Demonstrate lethality of the multimode warhead against ground mobile and relocatable targets - FY97.
- Perform component integration and risk reduction flight testing of the antimateriel submunition technology - FY99.

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- Demonstrate ordnance package development and evaluation tool as part of an Ada-based, object-oriented simulation of missile flyout from launch through fragment/target intercept - FY96.
- Complete flight testing of reaction control system for optimizing penetrator impact conditions and increasing weapon penetration - FY99.